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(54) [Title of the Invention] HEADLAMP FOR VEHICLE

(57) [Abstract]

[Object] To reduce the light curtain phenomenon of headlamps in bad weather.

[Structure] The position of the other vehicle present in front of the vehicle is recognized with a TV camera 22 and an image processing unit 48, and the cut line of headlamps 18, 20 is moved within the prescribed movement range by shade drive units 40, 41 according to the position of the other vehicle. If poor weather conditions such as the rain, mist, and the like, occur around the vehicle and a signal is input in a control unit, for example, if a wiper switch 68 or a fog lamp switch 70 is turned on, then the top dead center which is the uppermost position of the cut line movement range is changed to the position without the light curtain phenomenon and the cut line

is moved according to the position of the other vehicle within the movement range after the change has been made.

[Patent Claims]

[Claim 1] A headlamp for a vehicle comprising vehicle position detection means for detecting the position of the other vehicle, position changing means for changing the position of the cut line which is a boundary between an illumination region and a non-illumination region of the headlamp within the prescribed movement range, state detection means for detecting the state around the vehicle, and control means for controlling said position changing means based on the signals from said vehicle position detection means, wherein said position changing means changes the top dead center which is the uppermost position of the movement range of the cut line according to the signal from said state detection means.

[Claim 2] The headlamp for a vehicle, as described in claim 1, wherein said position changing means changes the top dead center of said cut line to the height of an almost horizontal plane of the lamp if said state detection means detects a meteorological state such as the rain, fog, and the like, in which the light curtain phenomenon of the headlamp occurs.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a headlamp for a vehicle, more specifically, to a headlamp for a vehicle which suppresses the light curtain phenomenon occurring in front of the vehicle during driving in bad weather.

[0002] Headlamps are installed on the left and right end at the front end side of the vehicles. The lights are turned on when the road in front of the vehicle is difficult to see, e.g., in the nighttime, in order to improve forward visibility for the driver. The headlamp usually has a structure allowing the lamp to be switched between two modes: a high beam mode in which the illumination range of the beam light is mainly far from the vehicle and a low beam mode in which the region close to the vehicle is illuminated. When other vehicles such as preceding or oncoming vehicles are present, a low beam mode is most often selected so as to avoid glare that blinds the drivers of other vehicles.

[0003] In a low beam mode of the headlamp, part of the beam light (beam light illuminating the remote region) is shielded. For example, in the projector-type headlamps, a light shielding plate (referred hereinbelow as a shade) for shielding part of the beam light is provided inside the headlamp. As a result, a boundary (this boundary will be referred to hereinbelow as a cut line) is formed between the region illuminated with the beam light in front of the vehicle and the region which is not illuminated, and the beam light emitted by the light source is divided into illuminating light and non-illuminating light.

[0004] However, the problem was that, for example, when the distance to the preceding vehicle

was large, it was difficult to illuminate the appropriate range in front of the vehicle all the time. Thus, in a low beam mode the driver continuously saw a dark zone, which was the non-illuminated region of the headlamp, whereas in the high beam mode, the driver of the preceding vehicle was blinded.

[0005] A variety of methods have been suggested to resolve this problem by ensuring the visibility (maximum possible illumination range) exceeding the visibility obtained in the low beam mode (close-distance illumination range) according to the conditions around the vehicle, an example of such conventional technology being disclosed in Japanese Patent Application Laid-open No. H1-278848 titled Illumination Apparatus for Vehicles. With the apparatus disclosed in this application, the position of the other vehicle is detected with a detection sensor arranged in the vicinity of a headlamp provided with a shade, the headlamp is moved in the vertical direction according to the detection signal, the cut line position is changed, and the visibility is improved by illuminating the maximum possible illumination range, while preventing blinding of the driver of the other vehicle.

[0006] Furthermore, a head light quantity control apparatus for vehicles disclosed in Japanese Patent Application Laid-open No. S63-129641 is an example of technology improving visibility in front of the vehicle in the rain. This apparatus comprises a vehicle sensor such as a rain drop sensor for detecting rain drops or a light sensor for detecting the presence of an oncoming vehicle and decreases or increases the quantity of light emitted by the headlamp by controlling the voltage with a light quantity setting device according to the signals of sensors.

[0007] With such a structure, the rain drop sensor detects the rain, sends the respective signal to the light quantity setting device and the light quantity setting device changes the control voltage so as to increase the quantity of light emitted by the headlamp over that emitted during nice weather. As a result, the visibility in front of the vehicle can be improved.

[0008]

[Problems Addressed by the Invention] However, when the vehicle is driven in the nighttime or in bad weather (for example, in the rain or mist), the beam light is reflected and scattered greater than during normal driving. As a result, the road may not be illuminated sufficiently and the visibility in front of the vehicle may be degraded. For example, when a headlamp is in a high beam mode in the rain, the beam light projected above the horizontal surface of the lamp is reflected and scattered, causing a light curtain phenomenon creating an impression that a white wall is present in front of the vehicle.

[0009] Within the framework of the conventional technology (Japanese Patent Application Laid-open No. H1-278848), when the front illumination was conducted by moving the cut line according to the position of another vehicle, if the cut line was raised above the horizontal plane of the lamp in order to illuminate the maximum possible range, without taking the adverse weather conditions into consideration, the light curtain phenomenon occurred in front of the vehicle and the visibility was degraded. Further, with the other conventional method (Japanese

Patent Application Laid-open No. S63-129641), there was a risk of the light curtain phenomenon similarly occurring if the quantity of light above the horizontal plane of the lamp was increased in the rain, without forming the cut line in the lamp.

[0010] Accordingly, it is an object of the present invention to reduce the light curtain phenomenon and to improve the visibility in front of the vehicle by changing the top dead center of the cut light moving range during poor weather and suppressing the quantity of light above the height of an almost horizontal plane of the lamp.

[0011]

[Means to Resolve the Problems] In order to resolve the above-described problems, the present invention provides a headlamp for a vehicle comprising vehicle position detection means for detecting the position of the other vehicle, position changing means for changing the position of the cut line which is a boundary between an illumination region and a non-illumination region of the headlamp within the prescribed movement range, state detection means for detecting the state around the vehicle, and control means for controlling the position changing means based on the signals from the vehicle position detection means, wherein the position changing means changes the top dead center which is the uppermost position of the movement range of the cut line according to the signal from the state detection means.

[0012] Further the above-mentioned position changing means changes the top dead center of the cut line to the height of an almost horizontal plane of the lamp if the state detection means detects a meteorological state such as the rain, fog, and the like, in which the light curtain phenomenon of the headlamp occurs.

[0013]

[Operation] With the headlamp for a vehicle in accordance with the present invention, the position of the other vehicle in front of the vehicle is recognized with the vehicle position detection means. The control means changes the position of the cut line based on the position signal of the other vehicle with the position changing means. At this time, if the state detection means detects the meteorological state around the vehicle, under which the light curtain phenomenon of the headlamp can occur, for example, the state of the rain or mist, the control means changes the top dead center of the cut line movement range of the position changing means to the height of an almost horizontal plane of the lamp and moves the cut line according to the position of the other vehicle within the movement range after the change has been made.

[0014]

[Embodiment] An embodiment of the present invention will be explained hereinbelow with reference to FIGS. 1 through 4. In the present embodiment, projector-type lamps were used as headlamps.

[0015] A front illumination lamp of the present embodiment, as shown in FIG. 4, comprises a TV

camera 22 and an image processing unit 48 as vehicle position detection means, a wiper switch 68 and a fog lamp switch 70 as state detection means, headlamps 18, 20, shade drive units 40, 41 comprising a shade forming a cut line as position changing means, and a control unit 50 as control means.

[0016] As shown in FIG. 1, a pair of headlamps 18, 20 are installed on both ends on the front edge portion in the lateral direction of a vehicle 10 on the front body 12 of the vehicle. A room mirror 16 is provided in the vicinity of the upper part of a window shield glass 14 located inside the vehicle 10. A TV camera 22 for taking the pictures representing the state in front of the vehicle is disposed close to the room mirror 16; the TV camera 22 is connected to an image processing unit 48.

[0017] Headlamps will be described below. Because the left and right lamps have the same structure, only the left headlamp 18 will be described. The headlamp 18 is a projector-type headlamp. As shown in FIG. 2 and FIG. 3, it is composed of a convex lens 30, a bulb 32, a lamp house 34, and a shade drive unit 40 comprising a shade 40A for cut line control. The lamp house 34 is secured in an almost horizontal position to a frame (not shown in the figures) of the vehicle. The convex lens 30 is secured to one opening of the lamp house 34, and the bulb 32 is secured via a socket 36 to the other opening so that the light emission point is positioned on the optical axis L (central axis of convex lens 30) of convex lens 30.

[0018] A reflector 38 with an elliptical reflective surface is formed on the valve 32 side inside the lamp house 34, and the beam light emitted by the bulb 32 is reflected by the reflector 38 and focused in the focal point on the optical axis L between the convex lens 30 and bulb 32. The shade drive unit 40 is installed in the vicinity of this focal point.

[0019] The shade drive unit 40 comprises the shade 40A rotatably supported on a rotary shaft 44 secured so as to be along the lateral direction of the vehicle inside the lamp house 34. A gear 40B is fixedly mounted on the shade 40A. A gear 40C fixedly mounted on the drive shaft of a motor 40D is engaged with the gear 40B. The motor 40D is connected to a driver 64 of a control unit 50, as shown in FIG. 4. Further, the shade 40A, as shown in FIG. 5, has a structure comprising a cam-shaped cross section 45 in which the distance from the rotary shaft 44 to the periphery changes continuously in the tangential direction, wherein the side surface has an almost cylindrical shape and changes continuously along the lateral direction of the vehicle. The cut line of the headlamp is formed by a horizontal portion 46 and an inclined portion 47 formed on the side surface of shade 40A.

[0020] The beam light of bulb 32 that has been reflected and focused by the reflector 38 is partially shielded by the shade 40A, and the remaining portion of the beam light is illuminated from the convex lens 30. The motor 40D is rotated by being driven according to the signals from the control unit 50. The position of the cut line of the beam line changes in the vertical direction according to the rotation of the shade 40A.

[0021] FIG. 6 and FIG. 7 illustrate schematically an illumination region 100 of the beam light in front of the vehicle. The reference symbol V denotes the central position of one headlamp and H

denotes the height of the horizontal plane of the headlamp. The cut lines of the illumination region 100 in the lateral direction of the vehicle are formed by the shade 40A shown in FIG. 2. The region shown by hatching above the cut line 102 is the region which is not illuminated with the beam light and the region below the cut line is the illumination region of the beam light.

[0022] When the shade 40A is rotated about the rotary shaft 44 with the motor 40D, the cut line 102 moves parallel to itself within a movement region from the first uppermost position H_1 (referred to hereinbelow as the first top dead center) shown by a solid line to the lowermost position L (referred to hereinbelow as the lower dead center) shown by a dash-dot line as a cut line 104. Further, the first top dead center H_1 of cut line is the uppermost position under usual conditions and the height thereof represents the position below the optical axis of the high beam. The second upper end point H_2 is the uppermost position in bad weather and the height thereof represents the position at the height of an almost horizontal plane of the headlamp. Further, the lower end point is a usual low beam position.

[0023] The configuration of the headlamp 18 was described above. Because the configuration of the right headlamp 20 is identical to that of headlamp 18, detailed explanation thereof will be omitted. The shade drive unit 41 is mounted on the headlamp 20, as shown in FIG. 4, and the cut line is moved by the shade drive unit 41.

[0024] As shown in FIG. 4, the control unit 50 comprises a read only memory (ROM) 52, a random access memory (RAM) 54, a central processing unit (CPU) 56, an input port 58, an output port 60, and a bus 62 such as a data bus or control bus connecting the above components. The ROM 52 stores the below-described control program for controlling shade drive units 40, 41. The RAM 54 temporarily stores a position signal for the vehicle recognized with the image processing unit 48. The CPU 56 sets the control signals for controlling the shade drive units 40, 41 according to the predetermined control program.

[0025] The wiper switch 68, fog lamp switch 70, and image processing unit 48 are connected to the input port 58. The image processing unit conducts processing of the image of the zone in front of the vehicle which is picked up with the TV camera 22 and specifies the position of the other vehicle based on the signals which are input from the TV camera 22 and control unit 50. The output port 60 is connected to the shade drive units 40, 41 via a driver 64. The output port 60 is also connected to the image processing unit 48. Furthermore, ON and OFF signals are supplied to the input port 58 from the wiper switch 58 and fog lamp switch 70, and a driver can detect changes in the meteorological conditions by turning those switches on and off.

[0026] The operation of the control unit changing the movement range of the cut line based on the signals from the TV camera, switches, and sensor will be described below with reference to FIG. 8 and FIG. 9. FIG. 8 is a flow chart of the main routine from the instant of recognizing the position of the vehicle to the instant the shade of the headlamp is moved. In Step 200, the other vehicle (oncoming vehicle or preceding vehicle) present in front of the vehicle is detected with the TV camera, image processing is conducted, and a position recognition treatment is conducted in which the position of the other vehicle is specified. In Step 202, a decision is made as to whether or not the conditions around the vehicle, in particular, meteorological conditions, have changed.

[0027] A subflow of Step 202 is explained below based on the flow chart shown in FIG. 9. In Step 300, the present position of the top dead center of the cut line is detected. In Step 302, a decision is made as to whether or not the rain has been falling around the vehicle and whether or not the wiper switch has been turned on. If the wiper switch has been turned on, the program proceeds to Step 310 and the movement range of the cut line is changed. If the wiper switch is turned off, in Step 304 a decision is made as to whereto there is a mist around the vehicle and whether or not the fog lamp switch has been turned on. If the fog lamp switch has been turned on, the program proceeds to Step 310 and the movement range of the cut line is changed. If the fog lamp is turned off, a decision is made that the meteorological conditions around the vehicle are good, the top dead center is set to the first top dead center H_1 in Steps 306, 308, and the cut line is moved according to the position of the other vehicle within the cut line movement range shown in FIG. 6 (within the range from the first top dead center H_1 to the lower dead center L).

[0028] If in any one of Steps 302, 304 a decision is made that the switch has been turned on, then a decision is made that the meteorological conditions around the vehicle correspond to bad weather and control (from Step 310 to Step 314) is conducted to change the range to the bad weather movement range (range from the second top dead center H_2 to the lower dead center L) shown in FIG. 7. In Step 310, a decision is made as to whether the top dead center of the cut line is above the second top dead center H_2. If it is above, then in Step 312 the top dead center is changed to the second top dead center H_2. If it is in the second top dead center H_2, the cut line is moved according to the position of the other vehicle within the bad weather movement range.

[0029] In Step 204, a control signal of the motor of the shade drive unit is set based on the other vehicle position signal obtained in Step 200 and the height of the top dead center set in Step 202. In Step 206, the shade drive unit is driven and the cut line is moved.

[0030] If the above-described flow is thereafter repeated, when the conditions around the vehicle correspond to poor weather conditions, in particular, those of the rain, mist, and the like, the top dead center of the cut line movement range is changed to almost the height of the horizontal plane of the lamp and the beam light will not be projected above the height of the horizontal plane of the lamp. Therefore, the light curtain phenomenon can be reduced. Moreover, because the cut line is moved according to the position of the other vehicle within the movement range after changing, the driver can have the optimum front visibility.

[0031] In the above-described embodiment, a projector-type lamp was used as the headlamp. However, the present invention can be also applied to other headlamps. Moreover, a shade located inside the headlamp was used as means for moving the cut line. However, the present invention is also applicable to the headlamps in which the headlamp bulb or lamp house is moved.

[0032] Furthermore, the cylindrical shade was used as the shade, but this shape of the shade is not limiting. Thus, a plate-like shade, a shade divided into a plurality of sections, and the like can be used in other embodiments.

[0033] In the above-described embodiment, the ON-OFF switching of the wiper switch and fog

lamp switch was employed for detecting the changes in meteorological conditions. However, signals of rain sensors, fog sensors, illumination sensors, and the like may be also used.

[0034]

[Effect of the Invention] In the headlamp for a vehicle in accordance with the present invention, when the other vehicle is detected with a camera or the like and the position of the cut line of the headlamp is changed accordingly within the prescribed movement range, the state around the vehicle, in particular, the meteorological conditions such as the rain, mist, and the like, are detected, the top dead center of the cut line movement range is changed to almost a horizontal plane of the lamp and the beam light is not projected above the height of the horizontal plane of the lamp. Therefore, visibility in front of the vehicle can be improved, while reducing the light curtain phenomenon.

[Brief Description of the Drawings]

FIG. 1 is a perspective view illustrating the front part of the vehicle using the headlamp which is an embodiment of the present invention.

FIG. 2 is a perspective view illustrating a schematic structure of the headlamp in the embodiment of the present invention.

FIG. 3 is a cross sectional view along the III-III line in FIG. 2.

FIG. 4 is a block diagram illustrating the schematic structure of the control unit in the embodiment of the present invention.

FIG. 5 is a perspective vies of a shade of the headlamp in the embodiment of the present invention.

FIG. 6 is a schematic view illustrating the cut line movement range in a normal state in the beam light illumination range in the embodiment of the present invention.

FIG. 7 is a schematic view illustrating the cut line movement range during poor weather in the beam light illumination range in the embodiment of the present invention.

FIG. 8 is a flow chart illustrating the main routine of the control in the embodiment of the present invention.

FIG. 9 is a flow chart illustrating changes of the cut line movement range in the embodiment of the present invention.

[Legends]

18, 20 HEADLAMP
22 TV CAMERA (VEHICLE POSITION DETECTION MEANS)
40, 41 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
48 IMAGE PROCESSING UNIT (VEHICLE POSITION DETECTION MEANS
50 CONTROL UNIT (POSITION CHANGING MEANS)
68 WIPER SWITCH (STATE DETECTION MEANS)
70 FOG LAMP SWITCH (STATE DETECTION MEANS)

FIG. 4

18 HEADLAMP
20 HEADLAMP
22 TV CAMERA (VEHICLE POSITION DETECTION MEANS)
40 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
41 SHADE DRIVE UNIT (POSITION CHANGING MEANS)
BATTERY
48 IMAGE PROCESSING UNIT (VEHICLE POSITION DETECTION MEANS
50 CONTROL UNIT (POSITION CHANGING MEANS)
58 INPUT PORT
60 OUTPUT PORT
64 DRIVER
68 WIPER SWITCH (STATE DETECTION MEANS)
70 FOG LAMP SWITCH (STATE DETECTION MEANS)

FIG. 6

NON-ILLUMINATED REGION
ILLUMINATED REGION

FIG. 7

NON-ILLUMINATED REGION
ILLUMINATED REGION

FIG. 8

200 POSITION RECOGNITION OF ANOTHER VEHICLE
202 SETTING THE CUT LINE (SHADE) MOVEMENT POSITION
204 SETTING THE CONTROL SIGNAL OF SHADE DRIVE UNIT
206 CUT LINE (SHADE) MOVEMENT

FIG. 9

300 DETECTION OF THE PRESENT TOP DEAD CENTER OF CUT LINE (SHADE) : X
302 WIPER SWITCH ON
304 FOG LAMP ON
308 TOP DEAD CENTER H_1 IN THE MOVEMENT RANGE IN THE NORMAL STATE
314 TOP DEAD CENTER H_2 IN THE MOVEMENT RANGE DURING POOR WEATHER

Continued from the front page
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【図1】本発明の実施例に利用した車両の前部を示す斜視図。

【図2】本発明の実施例におけるヘッドランプの概略構成を示す斜視図。

【図3】図2におけるIII－III線の断面図。

【図4】本発明の実施例における制御装置の概略構成を示すブロック図。

【図5】本発明の実施例におけるヘッドランプのシェードの斜視図。

【図6】本発明の実施例のビーム光の照射領域における通常時のカットラインの移動範囲を示す概略図。

【図7】本発明の実施例のビーム光の照射領域における悪天候時のカットラインの移動範囲を示す概略図。

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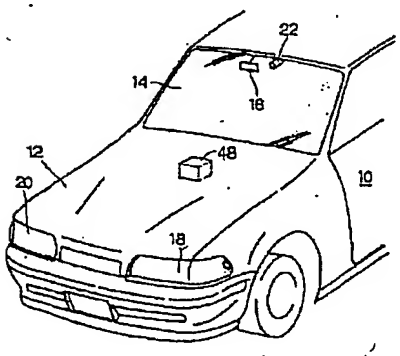
【図8】本発明の実施例における制御メインルーチンを説明するフローチャート。

【図9】本発明の実施例におけるカットラインの移動範囲の変更を説明するフローチャート。

【符号の説明】

18、20・・・　ヘッドランプ
22　　・・・　TVカメラ（車両位置検出手段）
40、41・・・　シェード駆動部（位置変更手段）
48　　・・・　画像処理装置（車両位置検出手段）
50　　・・・　制御装置（位置変更手段）
68　　・・・　ワイパスイッチ（状態検出手段）
70　　・・・　フォグランプスイッチ（状態検出手段）

【図1】



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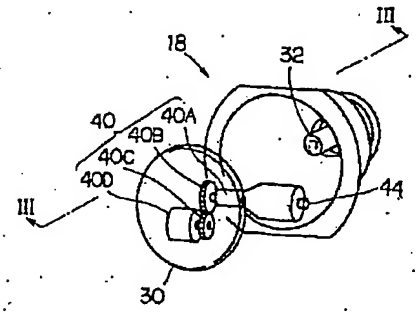

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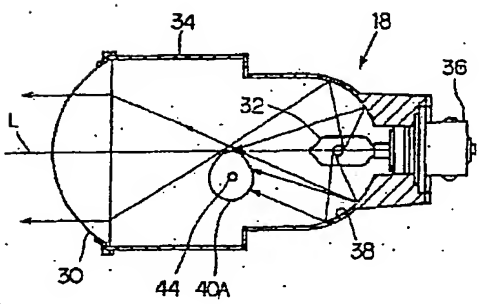

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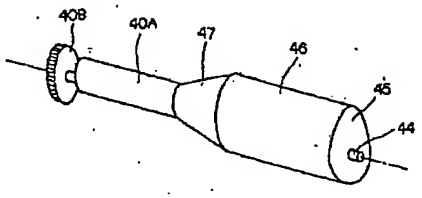

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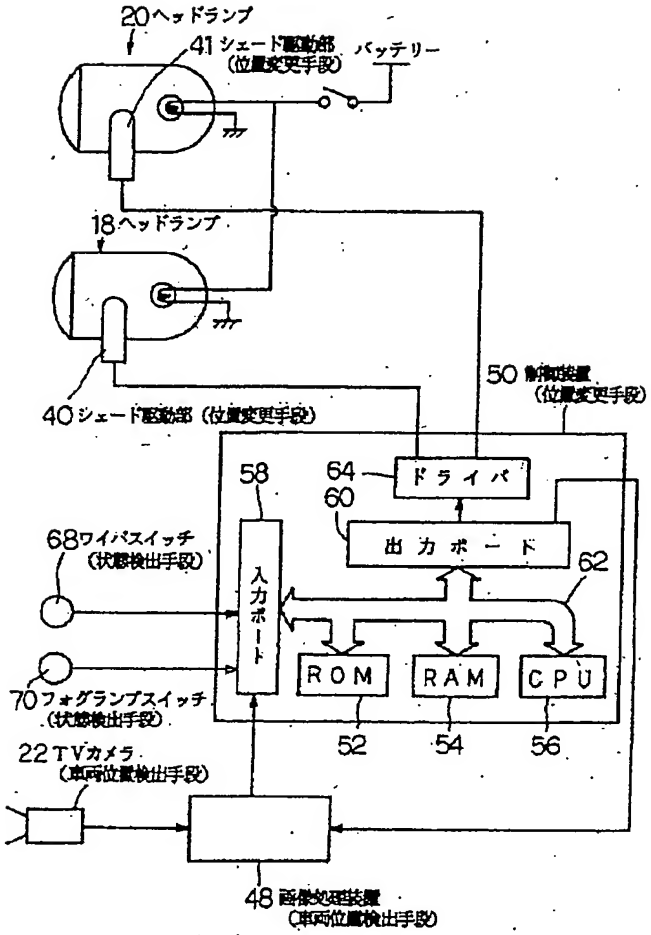
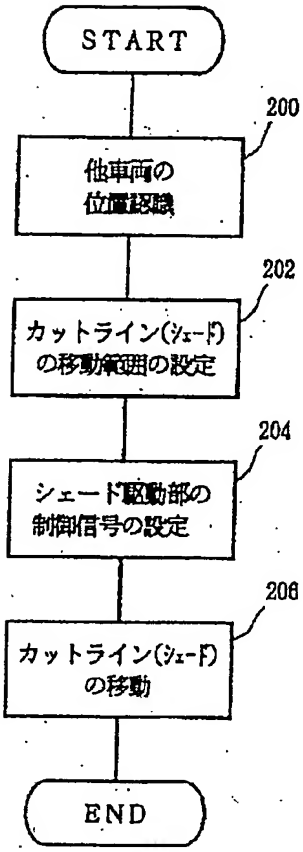

20ヘッドランプ
41 シェード駆動部
(位置変更手段)
バッテリー
18ヘッドランプ
40 シェード駆動部 (位置変更手段)
50 制御装置
(位置変更手段)
58
64
ドライバ
60
出力ポート
62
入力ポート
68ワイパスイッチ
(状態検出手段)
70フォグランプスイッチ
(状態検出手段)
ROM
RAM
CPU
52
54
56
22 TVカメラ
(車両位置検出手段)
48 画像処理装置
(車両位置検出手段)

【図8】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200
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位置認識
202
カットライン(シェード)
の移動範囲の設定
204
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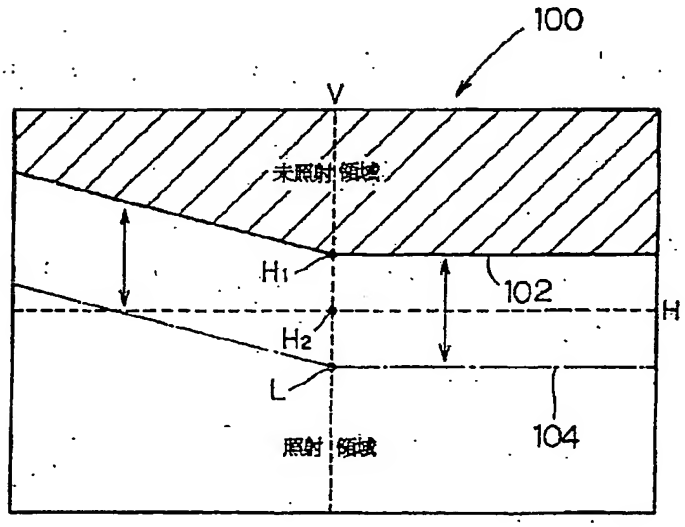
制御信号の設定
206
カットライン(シェード)
の移動
END

【図6】


100
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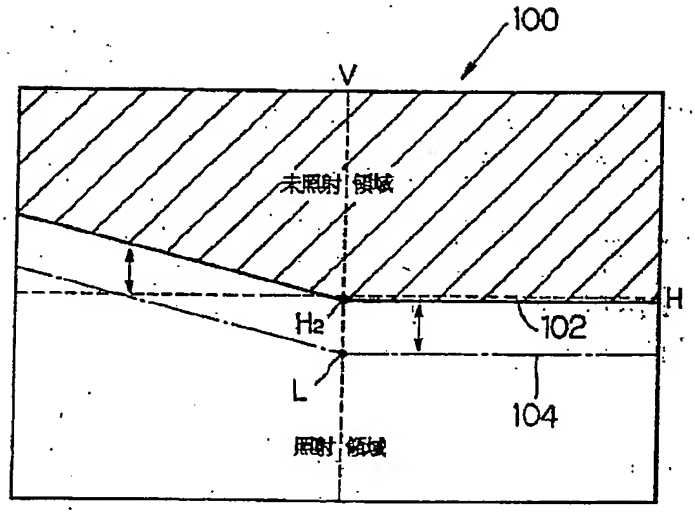
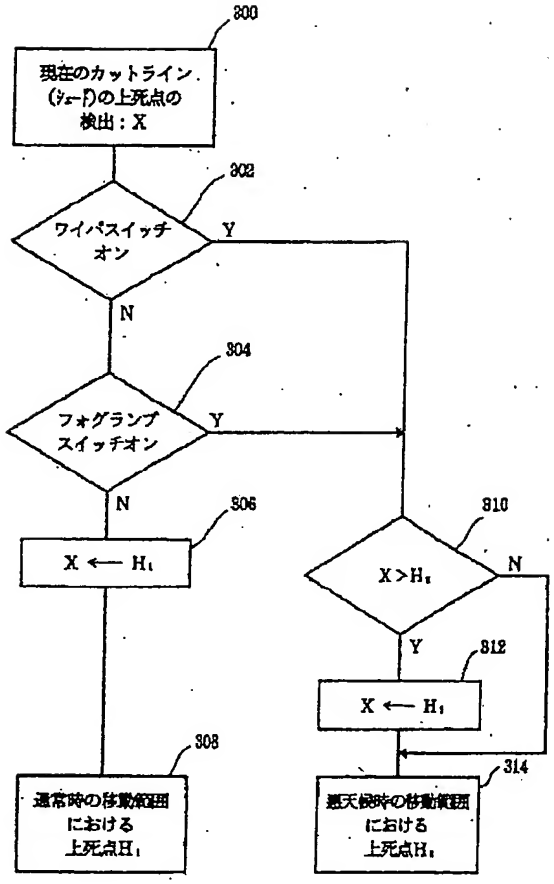
【図7】



【図9】



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